Chapter5

Multiplier Analysis and Linear Programming Optimization

5.1 Accounting Multiplier Matrix

In this chapter, the author assumes that Yunnan Province intends to perform a sustainable development social-economic objective in terms of the total value added, employment creation, environmental degradation, energy dependency, transportation dependency, poverty alleviation. Based on the assumption, the Micro SAM in table4.14 will be used to build the multiplier matrix. In this chapter, the accounting SAM multiplier will be used to evaluate the effect of a change in injection on various endogenous accounts. Then the linear programming (LP) will be used to explore an optimization situation for resource reallocation by different strategies.

The endogenous accounts in the paper will comprise the Commodities-Activities, Factors and Household. The exogenous accounts will comprise Enterprises, Government, Capital and Rest of World. Table 5.1 illustrates different matrixes in the SAM. Matrix N represents outlay transaction between endogenous accounts (CA, Value-added, and Household), and matrix L shows leakages from endogenous accounts into exogenous account (Enterprises, Government, Capital and Rest of World). The X matrix represents injections of income from exogenous accounts into endogenous ones and T is the matrix of expenditure transactions between exogenous accounts. According to the principle of SAM the column total and the row total should be equal.

Table5.1 the SAM model summarized by endogenous and exogenous

	Endogenous accounts				Total
Receipts / Expense	1.Productive/ Activities	2.Factors	3.Household	4.Exogenous accounts	
1.Productive activities	T_{11}		T_{13}	X_1	Y_1
2.Factors	T_{21}			X_2	Y_2
3.Household		T_{32}	T_{33}	X_3	Y_3
4.Exogenous accounts	L_1	L_2	L_3	LX	Y_4
Total	Y_1	Y_2	Y_3	Y_4	

Source: Jeffery Round, social accounting matrices and in SAM-based models: in retrospect and in prospect, University of Warwick, U.K.

For building a SAM-based multiplier model, we will compute column shares (column coefficients) from SAM to get matrix multipliers. Usually, beside the activities-commodities accounts, factor accounts and the household account will be commonly designated as endogenous accounts; the other institution accounts such like enterprise, government, investment and Rest of World will be designated as exogenous account. The reason is since government outlays are policy-determined, the Rest of World is outside of domestic control, and investment is exogenously determined within a static model. The corporate enterprise outlays (e.g. distributed profits and property incomes) are variously treated as either being exogenously or endogenously determined. For sake of simplicity, the exogenous accounts are often being aggregated as a single account to analyze the injections into the system and the leakages from it.

The matrix of endogenous transaction will be denoted by the matrix T, and the column shares matrix will be denoted by the matrix A, which is divided into elements in each column of T by its column total.

$$T = Ay \qquad (42)$$

The component submatrices of A are as follows: A_{21} is the matrix of value added share of factor incomes generated by activities; A_{32} is the shares of factor incomes distributed across household, and A_{13} exhibits the pattern of expenditure by each household group. Several submatrices show no transactions in the SAM and consequently are set to zero. Similarly x and y are, respectively, the vectors of exogenous injections and account totals, where, for example, x_1 is the vector of all purchases of final goods and services other than those by households and y_1, is the total demand for products. Then the table5.1 can be written as

$$Y = Ay + X$$

$$= (I - A)^{-1} X = M_A X \qquad (43)$$

Here, M_A is the SAM multiplier matrix, otherwise known as the matrix of "accounting multipliers". The accounting multiplier compute the simple multiplier effects on outputs of activities of production and importantly, on incomes of household groups. In more detail, the reductions in government expenditures reduce the activity levels and household incomes directly, but also indirectly (the multiplier effects) in that value added is reduced, lowering factor incomes and reducing household income according to the combinations of factors each household owns. However, SAM-based multiplier account not only for the direct and indirect effects but also for the induced effects on factor and household incomes and activities outputs due to the (Keynesian) income-expenditure multipliers.

Thus the general aggregate multiplier model can be expressed as follow:

$$dy = (I - A)^{-1}dx = M_A dx \quad (44)$$

When we deal with complex dynamic economic systems indeed of balance growth, we must offset the narrow pursuit of GDP growth with other goals, having to do with employment creation, reduced pollution, reduced energy use, enhanced use of the growing transportation infrastructure, etc. These separate subsets of multipliers each constitute an objective-specify multiplier for a class of rows in the model, and take the following form:

$$\sum_i^n dy_i = \sum_1^n (I - A)^{-1} dx \quad = \sum M_{Ai} dx \quad (45)$$

Where

$$i = \text{ a type of labor, polluting industry, energy sector, etc.}$$

Policy makers can then determine the weights they put on value added, pollution, energy, transportation, poverty alleviation, and employment to calculate an aggregate social welfare multiplier for each sector in the economy. In the following sections we shall illustrate this entire process using data from Yunnan province.

5.2 Multiplier effect analysis

5.2.1 The Accounting Multipliers Analysis on 6 Economic and Social Targets

From the Micro SAM, we set 6 economic and social targets including one total economic objective such like value added and 5 social objectives such like employment, poverty alleviation, transport, energy and environment. We then set the Value Added Multiplier $\boldsymbol{M_{VA-i}}$, Employment Creation Multiplier $\boldsymbol{M_{EC-i}}$, Poverty Alleviation Multiplier $\boldsymbol{M_{PA-i}}$, Transportation Dependency Multiplier $\boldsymbol{M_{T-i}}$, Energy Dependency Multiplier $\boldsymbol{M_{EE-i}}$, and Environmental Degradation Multiplier $\boldsymbol{M_{EV-i}}$ and rank by those multiplier to get a multiplier effect analysis which are listed as below:

The total Value added

The total value added is obtained from the accounting multiplier matrix which includes rows of VA-L.AG, VA-L.OR, VA-L.UR and VA-K. The Value Added Multiplier can get as following:

$$\sum_i^n dy_{VA-i} = \sum_1^n (I-A)^{-1} dx \quad = \sum M_{VA-i} dx \qquad (46)$$

Where

$$i = VA - L.AG, VA - L.OR, VA - L.UR \text{ and } VA - K$$

Table5.2 multiplier effect ranking by value added

Rank	Sector	Value added	Rank	Sector	Value added
1	Beans	1.267	22	transportation and storage	0.677
2	Tobacco	1.260	23	public administration	0.634
3	Sugar Crops	1.258	24	fertilizer	0.605
4	Other Farming	1.249	25	Extension services	0.576
5	Forestry	1.236	26	Timber and furniture	0.551
6	Animal husbandry	1.229	27	food and tobacco processing	0.546
7	Oil bearing Crops	1.220	28	metal and non-metal manufacturing	0.513
8	Grain Crops	1.188	29	other chemicals	0.503
9	waster	1.137	30	papermaking	0.406
10	Fisher	1.123	31	petroleum and natural gas extraction	0.369
11	finance and insurance	0.984	32	Coal mining and processing	0.359
12	telecommunication and logistics	0.842	33	machinery	0.347
13	Accommodation and restaurant	0.819	34	equipment	0.318
14	water	0.803	35	other manufacturing	0.296
15	retail and wholesale	0.802	36	coking	0.282
16	electricity and heat	0.755	37	gas	0.219
17	Scientific research	0.714	38	pesticides	0.218
18	metal and non-metal mining	0.695	39	Textiles and apparel	0.148
19	construction	0.689	40	Electronics, instruments, and office equipment	0.126
20	other services	0.687	41	oil refining	0.004
21	Tourism	0.687			

Source: calculated by the A matrix

From table5.2, the beans sector bring the highest value added multiplier 1.267 which means 1 million injection on dx will bring 1.267 million output dy_i on value added. The top 10 is beans, tobacco, sugar crops, other farming, forestry, animal husbandry, oil bearing crops, grain crops, waste, and fisher. It represent that Yunnan is still an agricultural province that is still highly depend on the agricultural sector. Among the agricultural sector, the beans are the most productive good which widely cultivated in the almost whole province, the tobacco are the second one which take account for a huge percentage on the total GNP and it also contribute the governmental income in terms of tax, agricultural employment. Overall, the agricultural sector gives the high multiplier effect on value added.

The employment creation

The employment creation multiplier is obtained from the accounting matrix which includes rows of VA-L.AG, VA-L.OR, VA-L.UR and VA-K. The Employment Creation Multiplier $\boldsymbol{M_{EC-i}}$ can be get as following:

$$\sum_i^n dy_{EC-i} = \sum_1^n (I-A)^{-1} dx \quad = \sum M_{EC-i} dx \qquad (47)$$

Where

$$i = VA-L.AG, VA-L.OR, VA-L.$$

The value added capital multiplier can be get as below:

$$\sum_i^n dy_{VAK-i} = \sum_1^n (I-A)^{-1} dx \quad = \sum M_{VAK-i} dx \qquad (48)$$

Where

$$i = VA-K$$

We then divide M_{EC-i} by M_{VAK-i} is to yield labor intensive technology multiplier M_{LI-i}. Here an absolutely multiplier and a relative multiplier are both chosen for analyzing the employment creation situation. According the technique which is used to monitoring the employment creation multiplier, we get a ranking in the table 5.3 as below:

Table5.3 multiplier ranking by employment creation

Rank	Sector	employment creation multiplier	labor intensive technique multiplier	value added	Rank	Sector	employment creation multiplier	labor intensive technique multiplier	value added
1	beans	0.95	3.03	1.27	22	other services	0.35	1.03	0.69
2	tobacco	0.95	3.01	1.26	23	timber and furniture	0.34	1.66	0.55
3	sugar crops	0.94	3.01	1.26	24	electricity and heat	0.34	0.80	0.76
4	other farming	0.94	2.99	1.25	25	fertilizer	0.32	1.13	0.61
5	forestry	0.93	3.06	1.24	26	food and tobacco processing	0.28	1.09	0.55
6	animal husbandry	0.92	2.92	1.23	27	other chemicals	0.27	1.20	0.50
7	oil bearing crops	0.91	2.91	1.22	28	metal and non-metal manufacturing	0.26	1.04	0.51
8	grain crops	0.88	2.83	1.19	29	coal mining and processing	0.22	1.52	0.36
9	fisher	0.83	2.78	1.12	30	petroleum and natural gas extraction	0.18	0.98	0.37
10	telecommunication and logistics	0.66	3.62	0.84	31	coking	0.17	1.60	0.28
11	accommodation and restaurant	0.53	1.79	0.82	32	machinery	0.17	0.97	0.35
12	water	0.47	1.41	0.80	33	papermaking	0.17	0.70	0.41
13	finance and insurance	0.45	0.86	0.98	34	equipment	0.16	1.05	0.32
14	transportation and storage	0.43	1.75	0.68	35	other manufacturing	0.15	1.02	0.30
15	scientific research	0.43	1.51	0.71	36	pesticides	0.13	1.56	0.22
16	public administration	0.42	1.99	0.63	37	gas	0.12	1.31	0.22
17	metal and non-metal mining	0.40	1.40	0.69	38	textiles and apparel	0.10	2.11	0.15
18	extension services	0.38	2.01	0.58	39	waster	0.09	0.08	1.14
19	tourism	0.38	1.24	0.69	40	electronics, instruments, and office equipment	0.07	1.22	0.13
20	construction	0.38	1.20	0.69	41	oil refining	0.00	1.46	0.00
21	retail and wholesale	0.37	0.84	0.80					

Source: calculated by the A matrix

From table5.3, the post sector brings the highest multiplier The top 10 from table5.3 are post, forestry, beans, tobacco, sugar crops, other Farming, animal husbandry, oil bearing crops, grain crops, and fisher. By observing the ranking we found that some industries related to knowledge economy in terms of post, extension services, and the scientific research have much higher multipliers than the average. It shows that the economy of China is indeed moving towards the "knowledge economy".

Environmental degradation

The Environmental Degradation Multiplier is obtained from the accounting matrix which includes all rows of polluting industries in terms of "Coal mining and processing", "petroleum and natural gas extraction", "metal and non-metal mining", "food and tobacco processing", "Textiles and apparel", "Timber and furniture", "papermaking", "oil refining", "coking", "fertilizer", "pesticides", "other chemicals", "metal and non-metal manufacturing", "equipment", "machinery", "Electronics, instruments, and office equipment", "other manufacturing", "waster", "electricity and heat", "gas", "water", "construction", "transportation and storage", "post", "retail and wholesale", and "accommodation and restaurant". The Environmental Degradation Multiplier M_{EV-i} can be get as following:

$$\sum_i^n dy_{EV-i} = \sum_1^n (I-A)^{-1} dx \quad = \sum M_{EV-i} dx \qquad (49)$$

Where

$$i = polluting\ industries\ as\ above$$

However, the environmental degradation multiplier $\boldsymbol{M_{EV-i}}$ has a positive effect on the economic objective; although it has negative effect for a sustainable development objective. Therefore, a sustainable development target should release the environmental degradation for controlling the expansion of the polluting industries.

Table5.4 multiplier ranking by environmental degradation

Rank	Sector	Environmental degradation multiplier	Value added multiplier	Rank	Sector	Environmental degradation multiplier	Value added multiplier
1	papermaking	1.39	0.41	22	tobacco	0.28	1.26
2	other chemicals	1.38	0.50	23	telecommunication and logistics	0.27	0.84
3	coking	1.35	0.28	24	beans	0.27	1.27
4	coal mining and processing	1.32	0.36	25	water	0.27	0.80
5	Accommodation and restaurant	1.19	0.82	26	forestry	0.27	1.24
6	pesticides	1.17	0.22	27	animal husbandry	0.25	1.23
7	petroleum and natural gas extraction	1.13	0.37	28	gas	0.24	0.22
8	waster	1.06	1.14	29	electricity and heat	0.24	0.76
9	oil refining	1.00	0.00	30	other services	0.24	0.69
10	fertilizer	0.47	0.61	31	fisher	0.23	1.12
11	transportation and storage	0.39	0.68	32	Timber and furniture	0.22	0.55
12	metal and non-metal mining	0.35	0.69	33	retail and wholesale	0.21	0.80
13	public administration	0.34	0.63	34	finance and insurance	0.20	0.98
14	tourism	0.34	0.69	35	extension services	0.19	0.58
15	construction	0.32	0.69	36	food and tobacco processing	0.16	0.55
16	grain Crops	0.31	1.19	37	machinery	0.16	0.35
17	scientific research	0.30	0.71	38	equipment	0.12	0.32
18	oil bearing Crops	0.29	1.22	39	other manufacturing	0.12	0.30
19	other Farming	0.28	1.25	40	electronics, instruments, and office equipment	0.07	0.13
20	metal and non-metal manufacturing	0.28	0.51	41	textiles and apparel	0.05	0.15
21	sugar Crops	0.28	1.26				

Source: calculated by the A matrix

For releasing the environmental degradation, the best and the smallest multiplier 10 industries are “textiles and apparel” ,“electronics, instruments, and office equipment”, “other manufacturing”, “equipment”, “machinery”, “food and tobacco processing”, “extension services”, “finance and insurance”, “retail and wholesale”, “Timber and furniture” which bring the least pollution for the low environmental degradation multiplier. The environmental degradation multiplier of the textiles and apparel is 0.053 which mean 1 million dollars injection dx will output 0.053 million dollars on environmental degradation.

However, some polluting industries like “papermaking”, “other chemicals”, “coking”, “coal mining and processing”, “accommodation and restaurant”, “pesticides”, “petroleum and natural gas extraction”, “waste”, “oil refining”, “fertilizer” have the highest environmental degradation multiplier. For example, “papermaking” bring the highest environmental degradation multiplier 1.394 which is means 1 million dollar injection dx will bring environmental degradation 1.394 million environmental degradation. The trade off for such injection will finally have a negative effect.

Energy dependency

The Energy Dependency Multiplier is obtained from the accounting matrix which includes all rows of energy industries in terms of “Coal mining and processing”, “oil refining”, “coking”, “electricity and heat”, “gas”,. The Energy Dependency Multiplier M_{EE-i} can be get as following:

$$\sum_i^n dy_{EE-i} = \sum_1^n (I-A)^{-1} dx \quad = \sum M_{EE-i} dx \tag{50}$$

Where

$$i = energy\ sector$$

Table5.5 multiplier ranking by energy dependency

Rank	Sector	Energy dependency multiplier	Value added multiplier	Rank	Sector	Energy dependency multiplier	Value added multiplier
1	electricity and heat	1.42	0.76	22	scientific research	0.14	0.71
2	gas	1.33	0.22	23	forestry	0.13	1.24
3	coking	1.33	0.28	24	animal husbandry	0.13	1.23
4	Coal mining and processing	1.28	0.36	25	public administration	0.13	0.63
5	oil refining	1.00	0.00	26	petroleum and natural gas extraction	0.13	0.37
6	fertilizer	0.45	0.61	27	accommodation and restaurant	0.13	0.82
7	metal and non-metal mining	0.31	0.69	28	fisher	0.11	1.12
8	transportation and storage	0.30	0.68	29	machinery	0.09	0.35
9	water	0.30	0.80	30	extension services	0.09	0.58
10	metal and non-metal manufacturing	0.28	0.51	31	retail and wholesale	0.09	0.80
11	construction	0.24	0.69	32	equipment	0.09	0.32
12	other chemicals	0.19	0.50	33	papermaking	0.09	0.41
13	grain crops	0.19	1.19	34	other services	0.08	0.69
14	oil bearing Crops	0.18	1.22	35	finance and insurance	0.08	0.98
15	telecommunication and logistics	0.16	0.84	36	other manufacturing	0.07	0.30
16	other Farming	0.16	1.25	37	food and tobacco processing	0.07	0.55
17	sugar Crops	0.16	1.26	38	pesticides	0.05	0.22
18	tobacco	0.16	1.26	39	textiles and apparel	0.03	0.15
19	beans	0.16	1.27	40	electronics, instruments, and office equipment	0.03	0.13
20	tourism	0.15	0.69	41	waster	0.03	1.14
21	timber and furniture	0.14	0.55				

Source: calculated by the A matrix

The indicator has positive effect on the economic objective; however, it has negative effect on the social objective. So, a sustainable development target should try to release the dependency on energy.

According the ranking of the multiplier in table5.5, the top 10 industries with the highest multipliers that should be limited are “electricity and heat”, “gas”, “coking”, “Coal mining and processing”, “oil refining”, “fertilizer”, “metal and non-metal mining”, “transportation and storage”, “water”, “metal and non-metal manufacturing”. Among these, the electricity and heat has the biggest multiplier which is 1.419 that means 1 million dollars injection on the electricity and heat will cause 1.419 million dollars output on the energy dependency industries. In contrary, the industries that have the smallest multiplier effect are “waste”, “electronics, instruments, and office equipment”, “textiles and apparel”, “pesticides”, “food and tobacco processing”, “other manufacturing”, “finance and insurance”, “other services”. “papermaking”, “equipment”. Among those industries, the multiplier of the waste is 0.027 which mean 1 million dollars injection on the waste industry will cause 0.027 million dollars output on the energy dependency which is good for release the dependency on the energy consumption.

Transportation dependency

The transportation dependency multiplier is identified as a single sector from the accounting multiplier matrix which is the row of the transportation and the storage. The investment on transportation will return not only the GDP but also contribute to employment creation for unskilled labor and the development of many related industries. Therefore, the transportation will cause a positive result on a sustainable target. Then, the ranking of transportation multiplier M_{T-i} will be showed in table5.6.

Table5.6 multiplier ranking by transportation dependency

Rank	Sector	Transportation multiplier	Value added multiplier	Rank	Sector	Transportation multiplier	Value added multiplier
1	transportation and storage	1.10	0.68	22	Scientific research	0.08	0.71
2	Tourism	0.32	0.69	23	water	0.07	0.80
3	metal and non-metal mining	0.23	0.69	24	coking	0.07	0.28
4	telecommunication and logistics	0.23	0.84	25	Extension services	0.06	0.58
5	construction	0.11	0.69	26	electricity and heat	0.06	0.76
6	metal and non-metal manufacturing	0.11	0.51	27	machinery	0.06	0.35
7	fertilizer	0.11	0.61	28	food and tobacco processing	0.06	0.55
8	Forestry	0.10	1.24	29	papermaking	0.05	0.41
9	Grain Crops	0.10	1.19	30	other services	0.05	0.69
10	Oil bearing Crops	0.10	1.22	31	Accommodation and restaurant	0.05	0.82
11	Other Farming	0.10	1.25	32	equipment	0.05	0.32
12	Sugar Crops	0.10	1.26	33	other manufacturing	0.04	0.30
13	Tobacco	0.10	1.26	34	finance and insurance	0.04	0.98
14	Beans	0.10	1.27	35	petroleum and natural gas extraction	0.03	0.37
15	Timber and furniture	0.09	0.55	36	gas	0.03	0.22
16	Coal mining and processing	0.09	0.36	37	pesticides	0.03	0.22
17	retail and wholesale	0.09	0.80	38	Textiles and apparel	0.02	0.15
18	Animal husbandry	0.08	1.23	39	Electronics, instruments, and office equipment	0.02	0.13
19	other chemicals	0.08	0.50	40	waster	0.01	1.14
20	Fisher	0.08	1.12	41	oil refining	0.00	0.00
21	public administration	0.08	0.63				

Source: calculated by the A matrix

The top 10 industries which bring the highest transportation dependency multiplier are “transportation and storage”, “tourism”, “metal and non-metal mining”, "post", "construction", "metal and non-metal manufacturing", "fertilizer", "forestry", "grain crops", "oil bearing crops". The multiplier of the transportation and storage is1.103 which means 1 million dollars injection on the transportation and storage will bring 1.103 million dollars on the transportation dependency.

Poverty alleviation

The poverty alleviation multiplier, an absolute rural household income multiplier, is obtained from the accounting multiplier matrix by summing up the income multipliers of all rural household types. Further, the relative rural household income multipliers can be obtained from the accounting multiplier matrix by calculating a ratio of the total rural household income multiplier over the total household income multiplier. The author uses them both to analyze the poverty alleviation situation. From the accounting multiplier matrix, we firstly calculate the poverty alleviation multiplier $\boldsymbol{M_{PA-i}}$ as below:

$$\sum_{ri}^{n} dy_{PA-i} = \sum_{r1}^{n}(I-A)^{-1}dx \quad = \sum M_{PA-i}dx \tag{51}$$

Where

$$i = \ a\ type\ of\ rural\ \ household$$

In the same way, we get the total household income multiplier as below:

$$\sum_{i}^{n} dy_{TI-i} = \sum_{1}^{n}(I-A)^{-1}dx \quad = \sum M_{TI-i}dx \tag{52}$$

Where

$$i = \ a\ type\ of\ \ household$$

Then we use M_{PA-i}divide the M_{TI-i} to get the relative rural household income multipliers M_{RRI-i}.

Table5.7 multiplier ranking by poverty alleviation

Rank	Sector	Poverty alleviation multiplier	Relative rural income multiplier	value added	Rank	Sector	Poverty alleviation multiplier	Relative rural income multiplier	value added
1	Beans	0.877	0.858	1.27	22	construction	0.194	0.437	0.69
2	Tobacco	0.870	0.856	1.26	23	public administration	0.194	0.414	0.63
3	Sugar Crops	0.868	0.856	1.26	24	waster	0.191	0.598	1.14
4	Forestry	0.860	0.860	1.24	25	electricity and heat	0.190	0.444	0.76
5	Other Farming	0.858	0.854	1.25	26	other services	0.186	0.439	0.69
6	Animal husbandry	0.843	0.856	1.23	27	other chemicals	0.171	0.527	0.50
7	Oil bearing Crops	0.828	0.847	1.22	28	fertilizer	0.170	0.443	0.61
8	Grain Crops	0.794	0.839	1.19	29	metal and non-metal manufacturing	0.140	0.442	0.51
9	Fisher	0.765	0.857	1.12	30	Coal mining and processing	0.115	0.462	0.36
10	Extension services	0.330	0.772	0.58	31	papermaking	0.102	0.463	0.41
11	Accommodation and restaurant	0.294	0.497	0.82	32	petroleum and natural gas extraction	0.098	0.437	0.37
12	telecommunication and logistics	0.274	0.392	0.84	33	machinery	0.093	0.443	0.35
13	finance and insurance	0.250	0.438	0.98	34	pesticides	0.092	0.608	0.22
14	Timber and furniture	0.234	0.600	0.55	35	other manufacturing	0.090	0.493	0.30
15	water	0.229	0.421	0.80	36	equipment	0.086	0.436	0.32
16	metal and non-metal mining	0.209	0.446	0.69	37	coking	0.085	0.428	0.28
17	food and tobacco processing	0.209	0.609	0.55	38	gas	0.065	0.447	0.22
18	Scientific research	0.208	0.422	0.71	39	Textiles and apparel	0.060	0.538	0.15
19	retail and wholesale	0.206	0.445	0.80	40	Electronics, instruments, and office equipment	0.035	0.433	0.13
20	transportation and storage	0.201	0.413	0.68	41	oil refining	0.00	0.47	0.00
21	Tourism	0.200	0.446	0.69					

Source: calculated by the A matrix

Table5.7 shows that the highest multipliers which contribute to the poverty alleviation almost come from the agricultural sectors in terms of “beans”, “tobacco”, “sugar crops”. “forestry”, “other farming”, “animal husbandry”, “oil bearing crops”, “grain crops”, “fisher”, “extension services”. Among those sectors, the poverty alleviation multiplier of the beans is 0.877 which is means that 1 million dollars injection dx will cause 0.877 million dollars on poverty alleviation. It also means the investment or input on the agricultural sectors will better contribute on anti-poverty objective. The relative rural household income multipliers are consistent with the poverty alleviation multipliers that increasing the investment on the agricultural sectors gives the highest output on release the gap of income between rural people and urban people.

5.2.2 The Integrated Sustainable Development Multiplier Analysis

Since the one economic objective and the five social objectives are not always consistent and they may, sometimes, contradict to each other, it is necessary to build an integrated sustainable development multiplier to balance the target for achieving maximum economic output and the targets for satisfying the social objectives. The author assume a sustainable development objective intend to encourage the positive effects in terms of the value added multiplier, employment creation multiplier, transportation dependency multiplier, poverty alleviation multiplier, and decrease the negative effects in terms of the environmental degradation multiplier and the energy dependency multiplier.

We want to find a reasonable balance between values added growth with 50% of our objective and the five environmental and social sustainability objectives summing equally to the summing 50% of our objective. We then build the integrated sustainable development multipliers in two ways in terms of the inverse method and negative method as below:

The inverse method

The $M_{inverse\ -i}$ will be built by weighting $\boldsymbol{M_{VA-i}, M_{EC-i}, M_{T-i}, M_{P-i}}$ with 0.5, 0.1, 0.1, 0.1 and weighting the inversed $\boldsymbol{M_{EV-i}\ and\ M_{EE-i}}$ **with 0.15 and 0.05** to limit the industries that has negative effects on the environmental and social. The reason for choosing the value of the two multipliers with 0.15 and 0.05, respectively, is that there are repetition parts among them and also they are assumed to be more important on environment conservation.

$$M_{inverse\ -i} = 0.5 \times M_{VA-i} + 0.1 \times M_{EC-i} + 0.15 \div M_{EV-i} + 0.05 \div M_{EE-i} + 0.1 \times M_{T-i} + 0.1 \times M_{P-i} \quad (53)$$

The inverse method then brings about the ranking by an inversed integrated sustainable development multiplier $M_{inverse\ -i}$ in table5.8 as below:

Table5.8 the integrated multiplier ranking by the inverse method

Rank	Sector	The inversed integrated multiplier	Rank	Sector	The inversed integrated multiplier
1	Textiles and apparel	4.799	22	Timber and furniture	1.531
2	Electronics, instruments, and office equipment	4.224	23	pesticides	1.428
3	waster	2.599	24	Scientific research	1.420
4	other manufacturing	2.253	25	public administration	1.389
5	equipment	2.091	26	water	1.319
6	food and tobacco processing	2.055	27	Tourism	1.313
7	finance and insurance	2.053	28	transportation and storage	1.211
8	Fisher	2.025	29	construction	1.193
9	Animal husbandry	1.980	30	electricity and heat	1.171
10	Forestry	1.953	31	Accommodation and restaurant	1.167
11	Beans	1.902	32	metal and non-metal mining	1.148
12	Extension services	1.890	33	metal and non-metal manufacturing	1.130
13	Tobacco	1.885	34	papermaking	1.018
14	Sugar Crops	1.880	35	gas	0.952
15	Other Farming	1.859	36	fertilizer	0.900
16	retail and wholesale	1.799	37	petroleum and natural gas extraction	0.858
17	machinery	1.799	38	other chemicals	0.806
18	Oil bearing Crops	1.793	39	Coal mining and processing	0.540
19	Grain Crops	1.726	40	coking	0.498
20	other services	1.723	41	oil refining	0.395
21	telecommunication and logistics	1.697			

Source: calculated by the A matrix

For persuading the sustainable development integrated objective, table5.8 shows that the top10 industries are “textiles and apparel”, “electronics, instruments, and office equipment”, “waste”, “other manufacturing”, “equipment”, “food and tobacco processing”, “finance and insurance”, “fisher”, “animal husbandry”, “forestry” with the biggest inversed integrated sustainable development multipliers.

The negative method

The $M_{negative\ -i}$ will be built by weighting $\boldsymbol{M_{VA-i}, M_{EC-i}, M_{T-i}, M_{P-i}}$ with 0.5, 0.1, 0.1, 0.1 and weighting the $\boldsymbol{M_{EV-i}}$ ***and*** $\boldsymbol{M_{EE-i}}$ **with -0.15 and -0.05** to limit the industries that has negative effects on the environmental and social. The reason to choose the two multipliers as -0.15 and -0.05 is because there are repetition parts among them and also they are assumed more important on environment conservation.

$$M_{inverse\ -i} = 0.5 \times M_{VA-i} + 0.1 \times M_{EC-i} - 0.15 \times M_{EV-i} - 0.05 \times M_{EE-i} + 0.1 \times M_{T-i} + 0.1 \times M_{P-i} \quad (54)$$

The inverse method then brings the ranking by an inversed integrated sustainable development multiplier $M_{negative\ -i}$ in table5.9 as below:

Table5.9 the integrated multiplier ranking by the negative method

Rank	Sector	The negative integrated multiplier	Rank	Sector	The inversed integrated multiplier
1	Beans	0.983	22	construction	0.459
2	Tobacco	0.977	23	Accommodation and restaurant	0.458
3	Sugar Crops	0.976	24	other services	0.455
4	Forestry	0.973	25	food and tobacco processing	0.421
5	Other Farming	0.968	26	electricity and heat	0.402
6	Animal husbandry	0.956	27	fertilizer	0.378
7	Oil bearing Crops	0.943	28	metal and non-metal manufacturing	0.360
8	Grain Crops	0.916	29	Textiles and apparel	0.331
9	Fisher	0.893	30	machinery	0.292
10	telecommunication and logistics	0.796	31	equipment	0.290
11	finance and insurance	0.592	32	other manufacturing	0.282
12	transportation and storage	0.591	33	Electronics, instruments, and office equipment	0.218
13	Extension services	0.539	34	other chemicals	0.216
14	water	0.536	35	gas	0.186
15	public administration	0.507	36	petroleum and natural gas extraction	0.154
16	Scientific research	0.506	37	pesticides	0.151
17	retail and wholesale	0.502	38	Coal mining and processing	0.126
18	metal and non-metal mining	0.487	39	papermaking	0.111
19	Tourism	0.485	40	coking	0.080
20	waster	0.478	41	oil refining	-0.005
21	Timber and furniture	0.470			

Source: calculated by the A matrix

For persuading the sustainable development integrated objective, table5.9 shows that the top10 industries are “beans”, “tobacco”, “sugar crops”, “forestry”, “other farming”, “animal husbandry”, “oil bearing crops”, “grain crops”, “fisher”, “post”.

Combining the two ways, we get the top 17 industries which are chosen by the integrated sustainable development multiplier that show in table5.10 as below:

Table5.10 Top 17 sectors for multi-objectives of the sustainable development

Ranking	Inverse ratio	Ranking	Negative
1	Textiles and apparel	1	Beans
2	Electronics, instruments, and office equipment	2	Tobacco
3	waster	3	Sugar Crops
4	other manufacturing	4	***Forestry***
5	equipment	5	Other Farming
6	food and tobacco processing	6	***Animal husbandry***
7	finance and insurance	7	Oil bearing Crops
8	***Fisher***	8	Grain Crops
9	***Animal husbandry***	9	***Fisher***
10	***Forestry***	10	telecommunication and logistics

Source: calculated by the A matrix

By observing the results of the two methods, we can found that 3 industries in commonly have been chosen by both of the two ways in terms of “fisher”, “animal husbandry” and “forestry”. The 3 industries should be encouraged by either the inverse method or the negative method.

The top 17 industries should be encouraged by Yunnan government are “textiles and apparel”, “beans”, “electronics, instruments, and office equipment”, “tobacco”, “waste”, “sugar crops”, “other manufacturing”, “forestry”, “equipment”, “other farming”, “food and tobacco processing”, “animal husbandry”, “finance and insurance”, “oil bearing crops”, “fisher”, “grain crops”,” telecommunication and logistics”.

5.3 Linear Program Optimization

5.3.1 Linear Programming Optimization Matrix

Table 4.14 is actually show an A matrix which show us a matrix contain $i \times j$ elements denoted as a_{ij} . It represents the share of the expenditure of sector j on sector i taking account for total expenditure of sector j. From last section we know that:

$$Y = Ay + X$$

$$(I - A)Y = X \qquad (55)$$

Where Y is a matrix of total income, X is a matrix of external injection,

Table 5.11 describes the whole feature of the process for the linear programming optimization. It should be noticed that the author uses our $(I - A)$ matrix, which they called $\dot{A}_{ij}$, instead of A matrix or Ma matrix. Since we assume that the total income should be great or equal to total expenditure, our calculation is based on the $(I - A)$ matrix, We assume an element in $\dot{A}_{ij}$ to be $\dot{a}_{ij}$. For optimization of the total GPP, this section will defines V_j , a vector with j columns obtained from the value matrix , to denote the percentage of value added in total revenue; Y_j, a vector with j columns obtained from the value matrix, to denote the 2002 level income of each economic activity; $\dot{Y}_j$, a vector with j columns, to denote the optimal level of each economic activity. Then we can get the percentage change the optimal over basement which are denoted as $(\dot{Y}_j - Y_j)/ Y_j$ for each j sector.

The target of the linear programming optimization is to maximize the optimal level of output $\sum_{j=1}^{57} \dot{Y}_j V_j^T$ in terms of the total value added.

However the optimal level of output will be readjusted with some constraints. (1) The income – expenditure (I-A) balance constraints is the first constraint denoted as $\sum_{j=1}^{57} \dot{A}_{ij} V_j^T$, a vector with i rows should be great than or equal to zero for each i

that is on the right hand side in the table. (2) Resource constraint is the second constraint denoted as $\sum_{j=1}^{57} \dot{A}_{kj} V_j^T$ (k=1 to 4), a vector with k rows, should be less than or equal to B_k where k= each production factor.

Table5.11 linear programming optimization matrix

j / i		Endogenous $j = 1\ to\ 57$	Right-hand side or row limit
% Value added in total revenue	$j = 1\ to\ 57$	V_j	-
Optimal level of each economic acivity	$j = 1\ to\ 57$	$\dot{Y}_j$	$\sum_{j=1}^{57} \dot{Y}_j V_j^T$
2002 level of each economic activity	$j = 1\ to\ 57$	Y_j	$\sum_{j=1}^{57} Y_j V_j^T$
% change optimal over 2002	$j = 1\ to\ 57$	$(\dot{Y}_j - Y_j)/ Y_j$	
Income – expenditure (I-A) balance constraints	$i = 1\ to\ 57$ $j = 1\ to\ 57$	$\dot{A}_{ij} = \begin{bmatrix} \dot{a}_{11} & \dots & \dot{a}_{1j} \\ \dots & \dots & \dots \\ \dot{a}_{i1} & \dots & \dot{a}_{ij} \end{bmatrix} \times \dot{Y}_j = \sum_{j=1}^{57} \dot{A}_{ij} V_j^T$	>= 0 for each i
Resource constraint	$k = 1\ to\ 4$	$\dot{A}_{kj} = \begin{bmatrix} \dot{a}_{k1} & \dots & \dot{a}_{kj} \\ \dots & \dots & \dots \\ \dot{a}_{k1} & \dots & \dot{a}_{kj} \end{bmatrix} \times \dot{Y}_j = \sum_{j=1}^{57} \dot{A}_{kj} V_j^T$	<= B_k where k= each production factor

Source: Peter Calkins (2007), the Faculty of Economics, Chiang Mai University

According to the principle that discussed and assumed above, a linear programming optimization will be calculated by the solver of the Microsoft Excel. The target cell is the summation of the vector of optimal output level times the vector of the ratio of value added $\sum_{j=1}^{57} \dot{Y}_j V_j^T$. The resource constraint will set the limitation with the production factors in terms of the farm land, non farm land, labour and the equity capital.

5.3.2 Scenario Analysis with Different Constraint by Industries

We then set 5 scenarios with different strategies as: scenario 1) 2002 basement situation; scenario 2) land-based strategy; scenario 3) labor-based strategy; scenario 4) capital-based strategy; scenario 5) balanced development strategy. The basement situation is the output level of 2002 which presents the current economic income for each sectors and also the amount of the resource use in terms of the factor input. The land-based strategy assumes that the farm land can be improved by 50% by increasing the efficiency of land use and non farm land can be improved by 30% by increasing the efficiency of land use. The other constraints remain the same or less than original level. The labor-based strategy assumes that the labor can be improved by 25% due to the increase in labor supply or higher efficiency. The other constraints remain at the same or a lower than the original level. The capital-based strategy assumes that the capital can be improved by 25% due to the increase in the capital supply. The other constraints remain at the same or less than the original level. The balance development strategy assumes that the farm land, non-farm land, labor and capital can be improved by 50%, 30%, 25% and 25%, respectively. The assumption above will give the evidences how much of the improvement for each sector or total can be improved by increasing the factor input.

The section uses the five scenarios to analyze the change of the optimal level to original level. It is more interesting to categorize those sectors into six parts of the GPP in terms of the value added, agricultural sector, energy sector, industry sectors, the services and household income.

1. The value added

The analysis on the value added includes the total GPP, VA-L.AG, VA-L.OR, VA-L.UR and VA-K with the basement, land strategy, labor strategy, capital strategy and the balance development strategy which can refer to the level and decomposition of GPP in value added terms in table5.12.

Table 5.12 level and decomposition of GPP in value added terms

Sector	Baseline scenario 2002	Land-based scenario		Labor-based scenario		Capital based scenario		Balanced development scenario	
		New level	% change from baseline	New level	% change from baseline	New level	% change from baseline	New level	% change from baseline
Total GPP (in value added terms)	17,459,019	17,459,019	0%	20,010,247	15%	19,272,546	10%	21,823,774	25%
VA-L.AG	3,896,905	4,710,663	21%	4,251,237	9%	3,260,033	-16%	6,041,274	55%
VA-L.OR	1,823,314	1,588,099	-13%	2,458,322	35%	2,007,401	10%	1,940,916	6%
VA-L.U	4,484,693	3,906,149	-13%	6,046,581	35%	4,937,479	10%	4,773,950	6%
VA-K	7,254,107	7,254,107	0%	7,254,107	0%	9,067,634	25%	9,067,634	25%

Source: calculated by the A matrix

The land-based scenario in table5.12 shows that if the amount of land supply or the efficient of the land use increase 50% and 30% in the farm land and the non-farm land, respectively, it will bring 21% improvement in the value added of agricultural labor to original level. However, it brings the negative effect on the value added of other rural labor, urban labor and capital. Therefore, the total value added (GPP) does not make any improvement and stays the same amount with 0% change.

The labor-based scenario indicates that if the amount of labor supply or the efficient of the labor increase 25%, it will bring 9%, 35%, 35% improvement in the value added of agricultural labor, other rural labor and urban labor, respectively. Finally, the total value added (GPP) can be improved by 15% of the original level.

The capital-based scenario indicates that if the amount of capital supply is increased by 25%, it will bring about a 10%, 10%, and 25% improvement in the value added of the value added of other rural labor, urban labor and capital, respectively. In contrast, it shows a negative effect on the value added of the agricultural labor 16%. Hence, the total value added (GPP) can be improved by 10% to the basement situation.

The balance development scenario indicates that if the farmland, the non-farmland, labor and capital are separately increased by 50%, 30%, 25% and 25%, respectively, at the same period, it will bring about a 55%, 6%, 6%, and 25% improvement in the value added of the agricultural labor, other rural labor, urban labor and capital. The total value added (GPP) can be improved by 25% to the original situation.

2. Agricultural sector

The analysis on the agricultural sectors includes 10 agricultural sectors in terms of grain crops, beans, oil bearing crops, sugar crops, tobacco, other farming, forestry, animal husbandry, fisher and extension services with the basement, land strategy, labor strategy, capital strategy and the balance development strategy which can refer to the Impact of development strategies on agricultural sector activities in table5.13.

Table 5.13 impact of development strategies on agricultural sector activities

Sector	Baseline scenario 2002	Land-based scenario		Labor-based scenario		Capital based scenario		Balanced development scenario	
		New level	% change from baseline	New level	% change from baseline	New level	% change from baseline	New level	% change from baseline
Grain Crops	1,873,232	1,047,458	-44%	1,172,598	-37%	997,117	-47%	1,314,876	-30%
Beans	174,054	**1,903,037**	**993%**	**1,846,365**	**961%**	**388,157**	**123%**	**3,794,387**	**2080%**
Oil bearing Crops	70,071	39,182	-44%	43,863	-37%	37,299	-47%	49,185	-30%
Sugar Crops	254,815	142,485	-44%	159,508	-37%	135,637	-47%	178,862	-30%
Tobacco	654,940	366,223	-44%	409,976	-37%	348,623	-47%	459,721	-30%
Other Farming	1,618,071	904,779	-44%	1,012,873	-37%	861,295	-47%	1,135,771	-30%
Forestry	624,754	**3,762,513**	**502%**	**2,568,747**	**311%**	**2,739,056**	**338%**	**3,500,323**	**460%**
Animal husbandry	2,333,280	776,110	-67%	847,809	-64%	719,320	-69%	977,769	-58%
Fisher	173,837	144,721	-17%	172,226	-1%	149,630	-14%	**179,249**	**3%**
Extension services	526,541	72,592	-86%	69,630	-87%	50,406	-90%	98,595	-81%

Source: calculated by the A matrix

The land-based scenario in table5.13 shows that if the amount of land supply or the efficient of the land use increase 50% and 30% in the farm land and no-farm land; it will bring 993% and 502% improvement in beans and forestry to the original level. However, this strategy would have a negative growth effect to the rest 8 agricultural sectors which change by -84%, -67, -44%, -44%, -44%, -44%, -44%, -17%. The land-based strategy encourages increasing the plantation of beans and forestry and decreasing the amount for other agricultural sectors.

The labor-based scenario indicates that if the amount of labor supply or the efficient of the labor increase 25%, it will bring 961% and 311% improvement in beans and forestry to the original level. However, it brings the negative effect to the remaining 8 agricultural sectors which are -87%, -64, -37%, -37%, -37%, -37%, -37%, -1%. The labor-based strategy suggests increasing the plantation of beans and forestry and decrease the amount for other agricultural sectors.

The capital-based scenario indicates that if the amount of capital supply is increased by 25%, it will bring about a 338% and 123% gain in forestry and beans compared to the original level. However, it causes a negative effect to the remaining 8 agricultural sectors, which are given by -90%, -69%, -47%, -47%, -47%, -47%, -47%, -14%, respectively The capital-based strategy suggests increasing the plantation of forestry and beans and decreasing the amount for other agricultural sectors.

The balanced development scenario indicates that if the farmland, the non-farmland, labor and capital separately increase 50%, 30%, 25% and 25% at the same period, it will bring 2080%, 460%, 3% improvement in beans, forestry and fisher to the original level. However, it comes along with a negative effect to the remaining agricultural sectors, which amounts to -81%, -58%, -30%, -30%, -30%, -30%, -30%. The capital-based strategy suggests increasing the plantation of beans, forestry and fishery and decreasing the amount for other agricultural sectors.

3. Energy sector

The analysis on the energy sectors includes 6 energy sectors in terms of coal mining and processing, petroleum and natural gas extraction, oil refining, coking, electricity and heat, and gas with the basement, land strategy, labor strategy, capital strategy and the balance development strategy which can refer to the Impact of development strategies on energy sector activities in table5.14.

Table 5.14 impact of development strategies on energy sector activities

Sector	Baseline scenario 2002	Land-based scenario		Labor-based scenario		Capital based scenario		Balanced development scenario	
		New level	% change from baseline	New level	% change from baseline	New level	% change from baseline	New level	% change from baseline
Coal mining and processing	576,096	261,091	-55%	300,185	-48%	245,958	-57%	330,247	-43%
petroleum and natural gas extraction	1,884	1,464	-22%	1,718	-9%	1,443	-23%	1,824	-3%
oil refining	1,169,719	562,371	-52%	1,093,230	-7%	574,136	-51%	679,464	-42%
coking	111,495	53,744	-52%	57,635	-48%	46,608	-58%	67,400	-40%
electricity and heat	1,934,615	910,213	-53%	1,115,244	-42%	931,840	-52%	1,124,962	-42%
gas	64,319	48,638	-24%	**66,338**	**3%**	57,577	-10%	59,644	-7%

Source: calculated by the A matrix

All the strategies include land-based, labor-based, capital-based, and the balance development in table5.14 shows that, at the optimized level, the output of each energy sector will decrease. This may suggest that the energy production in Yunnan is not efficient. Only under the labor-based strategy, a 3% positive increase in gas sector is found. Under every scenario, the coal mining and processing, petroleum and natural gas extraction, oil refining, coking, and electricity and heat will decrease at a high rate.

4. Industry sector

The analysis on the industrial sectors includes 15 sectors in terms of metal and non-metal mining, food and tobacco processing, textiles and apparel, timber and furniture, papermaking, fertilizer, pesticides, other chemicals, metal and non-metal manufacturing, equipment, machinery, electronics, instruments, and office equipment, other manufacturing, waste and water with the basement, land strategy, labor strategy, capital strategy and the balance development strategy which can refer to the impact of development strategies industrial sector activities in table5.15.

Table 5.15 impact of development strategies industrial sector activities

Sector	Baseline scenario 2002	Land-based scenario		Labor-based scenario		Capital based scenario		Balanced development scenario	
		New level	% change from baseline	New level	% change from baseline	New level	% change from baseline	New level	% change from baseline
metal and non-metal mining	894,933	250,896	-72%	285,949	-68%	233,520	-74%	312,881	-65%
food and tobacco processing	8,694,005	2,326,966	-73%	2,788,824	-68%	2,372,930	-73%	2,907,018	-67%
Textiles and apparel	792,379	644,714	-19%	**807,926**	**2%**	700,413	-12%	**800,213**	**1%**
Timber and furniture	334,848	**387,844**	**16%**	**447,832**	**34%**	**384,242**	**15%**	**486,767**	**45%**
papermaking	1,152,615	1,033,147	-10%	**1,244,866**	**8%**	**1,245,266**	**8%**	**1,225,784**	**6%**
fertilizer	713,443	551,468	-23%	532,102	-25%	425,029	-40%	698,457	-2%
pesticides	61,916	**87,631**	**42%**	**75,720**	**22%**	**66,305**	**7%**	**100,322**	**62%**
other chemicals	2,602,193	1,237,038	-52%	1,428,539	-45%	1,250,029	-52%	1,539,180	-41%
metal and non-metal manufacturing	5,509,339	1,000,541	-82%	1,191,929	-78%	960,924	-83%	1,240,111	-77%
equipment	2,170,626	690,364	-68%	956,131	-56%	701,863	-68%	828,326	-62%
machinery	577,562	256,678	-56%	305,621	-47%	269,532	-53%	311,373	-46%
Electronics, instruments, and office equipment	804,112	563,802	-30%	674,573	-16%	589,768	-27%	696,002	-13%
other manufacturing	116,276	54,089	-53%	64,954	-44%	56,510	-51%	66,511	-43%
waste	185,766	**185,766**	**0%**	114,737	-38%	185,766	0%	185,766	0%
water	132,421	100,264	-24%	**146,634**	**11%**	109,452	-17%	124,447	-6%

Source: calculated by the A matrix

The land-based scenario in table5.15 shows that if the amount of land supply or the efficient of the land use increase 50% and 30% in the farm land and no-farm land; it will bring about a 42% and 16% improvement in pesticides and timber and furniture to the original level. However, it comes along with a negative effect to the remaining 13 industrial sectors. The land-based strategy encourages increasing the input on the pesticides, timber and furniture, and decreasing the amount for other energy sectors.

The labor-based scenario indicates that if the amount of labor supply or the efficiency of the labor increases by 25%, it will bring about a 34%, 22%, 8% and 2% improvement in timber and furniture, pesticides, papermaking, and textiles and apparel relative to the original level. But it will have a negative effect to the remaining 11 industrial sectors. The land-based strategy encourages increasing input on the timber and furniture, pesticides, papermaking, and textiles and apparel.

The capital-based scenario indicates that if the amount of capital supply is increased by 25%, it will bring about a 15%, 8% and 7% improvement in timber and furniture, pesticides, papermaking relative to the original level. However, there is a negative effect to the rest 12 industry. The capital-based strategy suggests increasing input on the timber and furniture, pesticides, papermaking and decreasing the input for other industry sectors.

The balanced development scenario indicates that if the farmland, the non-farmland, labor and capital separately increase 50%, 30%, 25% and 25% at the same period, it will bring 62%, 45%, 6% and 1% improvement in pesticides, timber and furniture, papermaking, and textiles and apparel to the original level. However, there will be a negative effect to the remaining 11 industry sectors. The balance development strategy suggests increasing the input on pesticides, timber and furniture, papermaking, and textiles and apparel and decreasing the input for the other industry sectors.

5. Services sector

The analysis on the services sectors includes 10 sectors in terms of construction, transportation and storage, telecommunication and logistics, retail and wholesale, accommodation and restaurant, finance and insurance, tourism, scientific research, other services and public administration with the basement, land strategy, labor strategy, capital strategy and the balance development strategy which can refer to the impact of development strategies industrial sector activities in table5.16.

Table 5.16 impact of development strategies on service sector activities

Sector	Baseline scenario 2002	Land-based scenario		Labor-based scenario		Capital based scenario		Balanced development scenario	
		New level	% change from baseline	New level	% change from baseline	New level	% change from baseline	New level	% change from baseline
construction	6,577,225	162,495	-98%	214,877	-97%	160,451	-98%	199,176	-97%
transportation and storage	2,252,151	1,109,136	-51%	**2,426,420**	**8%**	1,072,701	-52%	1,347,564	-40%
telecommunication and logistics	96,169	65,941	-31%	**6,617,869**	**6781%**	71,546	-26%	81,645	-15%
retail and wholesale	3,387,126	1,615,864	-52%	1,958,826	-42%	1,584,898	-53%	2,012,106	-41%
Accommodation and restaurant	1,359,906	940,691	-31%	1,146,056	-16%	1,054,433	-22%	1,114,983	-18%
finance and insurance	1,153,100	**9,898,836**	**758%**	**8,676,631**	**652%**	**14,726,614**	**1177%**	**12,664,033**	**998%**
Tourism	205,193	42,388	-79%	59,159	-71%	51,161	-75%	51,803	-75%
Scientific research	524,295	**585,136**	**12%**	**589,232**	**12%**	**581,376**	**11%**	**595,995**	**14%**
other services	7,081,294	3,874,536	-45%	4,570,701	-35%	4,723,773	-33%	4,782,803	-32%
public administration	2,898,829	2,905,148	0%	2,906,490	0%	2,905,167	0%	2,905,446	0%

Source: calculated by the A matrix

The land-based scenario in table5.16 shows that if the amount of land supply or the efficient of the land use increase 50% and 30% in the farm land and no-farm land; it will bring a 758% and 12% improvement in finance and insurance, and scientific research, respectively. However, there is a negative effect on the remaining 8 service sectors. The land-based strategy encourages increasing input on the finance and insurance, scientific research and decreasing the amount for other services sectors.

The labor-based scenario indicates that if the amount of labor supply or the efficient of the labor increases by 25%, it will bring an 6781%, 652%, 12% and 8% improvement in telecommunication and logistics, finance and insurance, scientific research, and transportation and storage to the original level. However, there will be a negative effect to the remaining 6 services sectors. The land-based strategy encourages increasing input on telecommunication and logistics, finance and insurance, scientific research, and transportation and storage and decreasing the amount for other services sectors.

The capital-based scenario indicates that if the amount of capital supply is increased by 25%, it will bring about a 1177% and 11% improvement in finance and insurance, and scientific research, respectively. However, there will be a negative effect on the other 8 services sectors. The capital-based strategy suggests increasing input on finance and insurance, and scientific research, and decreasing the input for other services sectors.

The balanced development scenario indicates that if the farmland, the non-farmland, labor and capital separately is increased by 50%, 30%, 25% and 25% at the same period, it will bring an 998% and 14% improvement in finance and insurance, and scientific research, respectively. However, there will be a negative effect to the other 8 services sectors. The balance development strategy suggests increasing input on finance and insurance, and scientific research, and decreasing the input for other services sectors.

6. Household income

The analysis on the household sectors includes 12 sectors in terms of RH1, RH2, RH3, RH4, RH5, UH1, UH2, UH3, UH4, UH5, UH6, UH7 with the basement, land strategy, labor strategy, capital strategy and the balance development strategy which can refer to the impact of development strategies industrial sector activities in table5.17.

Table 5.17 impact of development scenarios on the distribution of income

Sector	Baseline scenario 2002	Land-based scenario		Labor-based scenario		Capital based scenario		Balanced development scenario	
		New level	% change from baseline	New level	% change from baseline	New level	% change from baseline	New level	% change from baseline
RH1	856,223	815,421	-5%	854,609	0%	770,674	-10%	**1,029,649**	**20%**
RH2	1,055,636	1,048,106	-1%	**1,104,250**	**5%**	953,961	-10%	**1,324,994**	**26%**
RH3	1,269,540	**1,287,712**	**1%**	**1,360,218**	**7%**	1,149,681	-9%	**1,628,832**	**28%**
RH4	1,529,602	**1,580,041**	**3%**	**1,672,623**	**9%**	1,387,723	-9%	**1,999,558**	**31%**
RH5	2,344,075	**2,467,783**	**5%**	**2,618,159**	**12%**	2,130,770	-9%	**3,124,533**	**33%**
UH1	273,681	221,521	-19%	**307,779**	**12%**	**279,109**	**2%**	272,519	0%
UH2	336,516	276,855	-18%	**396,085**	**18%**	**349,121**	**4%**	**340,012**	**1%**
UH3	844,626	695,926	-18%	**998,256**	**18%**	**877,647**	**4%**	**854,549**	**1%**
UH4	1,100,059	910,584	-17%	**1,316,691**	**20%**	**1,148,626**	**4%**	**1,117,600**	**2%**
UH5	1,290,010	1,082,029	-16%	**1,600,081**	**24%**	**1,365,798**	**6%**	**1,326,219**	**3%**
UH6	732,663	620,044	-15%	**930,470**	**27%**	**783,002**	**7%**	**759,285**	**4%**
UH7	953,674	805,032	-16%	**1,203,062**	**26%**	**1,016,479**	**7%**	**986,070**	**3%**
Total increase in rural incomes	-	143,988	2%	554,784	8%	-662,266	-9%	2,052,491	29%
Total increase in urban incomes	-	-919,238	-17%	1,221,194	22%	288,552	5%	125,023	2%
"Scissors" ratio of urban to rural incomes	78%	64%	-	89%	-	91%	-	62%	-
Total income to poorest households	1,466,419	1,313,797	-10%	1,558,473	6%	1,398,904	-5%	1,642,180	12%
Total income to richest households	4,030,412	3,892,859	-3%	4,751,691	18%	3,930,250	-2%	4,869,888	21%
Quintile ratio top 20 to bottom 20 %	3	3	-	3	-	3	-	3	-

Source: calculated by the A matrix

The land-based scenario in table5.17 shows the land strategy does not work well for improving the household income. If the amount of land supply or the efficient of the land use increases by 50% and 30% in the farm land and no-farm land, it will only result in an 5% , 3% and 1% improvement in RH3, RH4 and RH5. But it will be accompanied by a stronger negative effect on the rest 9 household sectors. The total rural household income is increased by 2% and the total urban household income is decreased by 17%. "Scissors" ratio of urban to rural incomes is 64%, which is less than original level 78%. Comparing the original level, the total income to poorest households decrease 10%; the total income to richest households decrease 3%. The quintile ratio top 20 to bottom 20 % is 3 times.

The labor-based scenario indicates that the labor-based strategy works very well for improving all household income. If the amount of labor supply or the efficient of the labor increase 25%, the labor strategy does work well for improving the household income for all the types of household from 5% to 26%. However, RH1, the poorest rural household, can not be improved. The total rural household income increases by 8% and the total urban household income increases by 22%. "Scissors" ratio of urban to rural incomes is 89% which is bigger than original level 78%. Comparing the original level, the total income to poorest households increases by 6%; the total income to richest households increases by 18%. The quintile ratio top 20 to bottom 20 % is 3 times.

The capital-based scenario indicates capital strategy works well for urban household rather than rural household. If the amounts of capital supply increase 25%, it will improve the urban household income from 2% to 7% but decrease the rural household income from 9% to 10% for each type of household. The total rural household income decrease 9% and the total urban household income increase 5%. "Scissors" ratio of urban to rural incomes is 91% which is bigger than original level 78%. Comparing the original level, the total income of the poorest households decreases by 5%; the total income to richest households decreases by 2%. The quintile ratio top 20 to bottom 20 % is 3 times.

The balanced development scenario indicates that the balance development strategy works well both rural households and urban household. Noticeably, rural household income gets more improved. If the farmland, the non-farmland, labor and capital separately increases by 50%, 30%, 25% and 25% at the same period, it will improve the urban household income from 1% to 4% and the rural household income from 20% to 33% for each type of household. The total rural household income increase 29% and the total urban household income increase 2%. "Scissors" ratio of urban to rural incomes is 62% which is less than original level 78%. Comparing the original level, the total income to poorest households increase 12%; the total income to richest households increase 21%. The quintile ratio top 20 to bottom 20 % is 3 times.